PATENT SPECIFICATION 1,083,003

DRAWINGS ATTACHED.

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1,083,003

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COMPLETE SPECIFICATION.

Hot Metal Spraying of Bearing Materials.

We, THE GLACIER METAL COMPANY LIMITED, a Company registered under the Laws of Great Britain, of 368, Ealing Road, Alperton, Wembley, Middlesex, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to plain bearings and bearing material comprising at least two different metals, or alloys, and to a method and apparatus for manufacturing such bearing materials. This invention is particularly concerned with a bearing or bearing material including aluminium (or an aluminium based alloy) and lead.

The term "plain bearing" is to be understood as including any member or assembly having, or designed to have in use, a surface which bears directly or through a liquid or solid lubricant against another surface relative to which it has sliding movement, irrespective of whether the main or sole purpose is to transmit a load from one to the other of the surfaces having relative sliding movement or whether the sliding contact is solely or partly for some other purpose such, for example, as to provide a seal or to make electrical contact.

The term "lead" used herein is to be understood as including not only lead in substantially pure state but also lead alloys embodying for example, tin, indium, antimony or other alloying elements giving to the lead corrosion resisting or other desirable characteristics. The lead may for example contain up to 20% of its weight of tin or antimony or up to 10% of its weight of indium. Similarly the term "tin" as used herein is to be interpreted as including tin alloys.

The term "aluminium" used herein is to be understood as including not only substantially pure aluminium but also aluminium with the impurities normally found in commercial aluminium, as well as aluminium alloys containing alloying elements such as copper, nickel, manganeses, silicon, and magnesium for strengthening purposes.

In a bearing material which includes two constituent metals, one constituent metal often has a much higher specific gravity than the other. This is particularly true of aluminium and lead and to a lesser extent is true of aluminium and tin. This difference in specific gravity gives rise to the problem of the heavier constituent settling out from the lighter constituent when the heavier constituent is not soluble in the lighter constituent at or just above the melting point of the lighter constituent.

According to one aspect of the present invention a plain bearing material comprises a backing strip on which is deposited by hot metal spraying a bearing layer consisting of finely comminuted particles of at least two different metal constituents, one constituent comprising aluminium while the other constituent comprises lead.

According to a preferred feature of the invention a spray-deposited intermediate bonding layer is included between the backing strip and the bearing layer, formed of a material different from those of the backing strip and the bearing layer.

For example this intermediate layer may comprise a molybdenum based material, or

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a nickel aluminide material, or a copper or copper-based material.

The backing strip may be formed of aluminium, for example aluminium foil, which can subsequently be attached to a more rigid support.

Alternatively the backing strip may be of ferrous material such as steel which may be coated with a layer of nickel or other material having a weak oxide surface film, before the bearing layer or intermediate layer is deposited thereon. Other possible coating metals for a steel base are aluminium, copper, zinc, indium and silver.

Preferably the two constituent metals are sprayed in the form of hot plastic particles simultaneously onto the backing strip. The term "plastic" is intentionally used in preference to "molten" to indicate that the hot metal particles are not completely fluid at the moment of impact onto the strip.

In one preferred method according to the invention, one constituent is sprayed through a group of nozzles arranged transversely across the backing strip, to form a wide fan-like spray jet giving substantially even deposition, and the other constituent is sprayed simultaneously from another spray gun so that the sprayed areas overlap or substantially coincide. By creating an overlap of the sprayed areas in the direction of relative movement of the backing strip the two constituents are caused to intermingle, and at the same time a greater proportion of one constituent is applied adjacent the backing strip while a greater proportion of the other constituent exists at the bearing surface.

In another convenient method of performing the invention the two different metals are fed in the form of a single composite wire or strip to a spray gun. This permits the spraying to be effected with a single spray gun whereas normally it is necessary to use at least two spray guns, and in the case of aluminium and lead it is normally necessary to provide at least two guns for spraying aluminium, and one gun for spraying lead, because of the low proportion of lead required in the final product.

The composite wire may consist of an aluminium rod with a lead core, or an aluminium core with a lead sheath.

According to another preferred feature of the invention the backing material is preheated to a temperature of at least 150°C before the metals are sprayed thereon. Depending on the speed of strip movement, the closeness of the guns, and the nature of the metal being sprayed, it may be necessary to cool the strip to prevent pools of molten metal lying on it.

To build up the required layer thickness, the strip can be passed to and fro lengthwise under the guns, each layer of the sprayed metal being preferably between 0.004" and 0.010" in thickness, and a total thickness of the sprayed metals of preferably between 0.02" and 0.06" is achieved. It is very desirable that the completed layers of sprayed metal should be compacted, for example by rolling, with or without heat treatment, after being deposited. The proportion of aluminium in the completed layer may vary appreciably, for example between 70% and 98% by weight. In general the proportion of aluminium may be approximately 80%.

The invention also resides in a method of manufacturing a bearing or bearing material which includes the steps of plating a steel backing with a non-ferrous metal, treating the plated coating so as to provide a roughened surface, heating the plated steel backing to a temperature of at least 150°C, directing a number of spray gun nozzles so as to eject finely comminuted hot particles of aluminium and lead towards the plated steel backing while providing relative movement between the backing and the nozzles, compacting the finely comminuted metal adhering to the roughened surface by rolling and heat treating the products.

The invention may be performed in various ways and some specific details and embodiments will now be given by way of example with reference to the accompanying drawings, in which

Figure 1 is a diagrammatic plan view of one form of spraying apparatus in accordance with the invention,

Figure 2 is a diagrammatic sectional end elevation of the apparatus along the section line II—II of Figure 1,

Figure 3 is a perspective view of the apparatus, and

Figure 4 is a sectional end elevation of the backing strip, on an exaggerated vertical scale, showing the spray deposited layers.

In the first example the backing strip is a conventional steel bearing backing which is heated to a temperature of at least 150°C.

The cleaned backing strip is then passed under a metal spray gun arranged to spray aluminium and lead simultaneously onto the surface of the strip. The strip is passed to and fro under the gun to build up a series of layers of sprayed material. The proportion of aluminium and lead in the composite wire feed for the gun is controlled to obtain the required proportion of metals in the sprayed layer, which in one particular example is 5% by volume of lead. The composite wire may be obtained by forming a bore in an aluminium billet and filling the bore with lead and then extruding and drawing the bi-metallic billet to form the lead wire coated with aluminium. Alternatively the composite wire material may be in the form of aluminium wire coated with lead.

After the spray-deposited metal layers have

been built up to the required thickness of between 0.02" and 0.06" the bearing material is then compacted by rolling and finally heat treated. The reduction in thickness may be between 10% and 70%, and is preferably at least 25%. The finishing operations reduce the thickness of the sprayed bearing layer to between 0.020" and 0.025". A homogeneous bearing layer is achieved.

In the second embodiment a number of individual guns are used to spray aluminium simultaneously, with one gun spraying lead. The apparatus is illustrated in the drawings and comprises three aluminium spray guns 2, 3, 4, each capable of spraying aluminium at rates of 18 lbs. per hour, and one gun 5 capable of spraying lead at 25 lbs. per hour. The guns are all adjustable as to the rates at which they can spray the respective metal.

The backing strip 1 is supported by rollers or other means (not shown) so as to travel continuously beneath the spray guns in a horizontal path in the direction of arrow A in Figure 1.

The central aluminium spray gun 2 sprays substantially perpendicularly onto the strip and the spray from its nozzle extends over the full width of the strip. However the thickness of the deposit from this central gun may tend to increase at the centre and decrease at the edges, as shown by the section 10 in Figure 4. The two side aluminium spray guns 3 and 4, being directed slightly inwards, complement the spray from the central gun, and produce deposits 6 and 7 which combine to produce a substantially even overall deposit extending transversely across the backing strip.

The lead spray gun 5, which lies immediately up-or down-stream of the guns 2, 3 and 4, is arranged to produce a lead spray 13 over a width 9 which somewhat exceeds the width of the backing strip, and thus completely covers the strip. The area of the lead spray substantially coincides with the area of the aluminium spray so that the two metal constituents intermingle. However by slightly shifting the area of the lead spray downstream, that is in the direction of arrow A, the proportion of aluminium adjacent the backing strip can be increased, and the proportion of aluminium adjacent the actual bearing surface reduced. But care should be taken to avoid a continuous part layer of lead alone in the body of the strip.

All the spray guns are universally adjustable both as to position and angular attitude. Also the speed of travel of the backing strip is adjustable to assist in controlling the thickness of the sprayed deposit. The aluminium spray guns are preferably positioned with their nozzles at a distance of between 4 inches and 8 inches from the surface of the backing strip, i.e. as close as possible without causing the sprayed particles to become molten. The lead gun may be 3 inches further from the strip.

Preferably means are provided for directing an inert or reducing gas into or around the areas where the metal is being sprayed. The gas may be for example argon, nitrogen or carbon dioxide. High velocity gas streams can also be used around the metal spray jets, to control the shape of the jets. For example by directing a blast of nitrogen against the surface of the backing strip on both the upstream and downstream sides of the area being sprayed by the nozzles the spray jet can be widened across the backing strip, and the dimension of the spray jet in the direction of arrow A reduced. This shape-controlling nitrogen supply is preferably at a pressure above the pressure of any nitrogen supplied to the spray guns themselves, and is controlled independently. Nitrogen could also be used instead of the usual blast air in the gun for breaking up the metal into particles.

The spray guns are preferably of a type using a gas flame, but electric arc spray guns, or plasma spraying may be used. It would also be possible to spray the metal by causing a jet of compressed gas to break up a flow of the molten metal into small hot plastic particles.

In a possible further modification, the nickel plated steel backing strip is first sprayed with a layer of aluminium having little or no lead content, and as successive layers are applied the proportion of lead is increased. The final layer may consist of substantially pure lead, or if desired the lead may contain a proportion of tin to resist corrosion by hot lubricating oils.

In yet another possible modification the aluminium and lead are sprayed onto a backing strip in the form of thin aluminium foil and the foil is then subsequently bonded to a more rigid backing material.

It is found in general that bearing materials manufactured in accordance with the invention are superior in many ways, particularly in bond strength, to bearing materials manufactured by more conventional techniques of roll bonding.

Finally some examples of bearing layer compositions are given. The percentages are all by weight.

(i) Lead 19%
Tin 1%
Balance aluminium.

(ii) Lead 19%
Tin 1%
Silicon 5%
Balance aluminium.

(iii) Lead 18¾%
Antimony 1¼%
Tin 1%
Balance aluminium.

(iv) Lead 18¾%
Antimony 2%
Balance aluminium.

(vi) Tin 20%
Lead 5—10%
Copper 2%
Balance aluminium.

(vii) Lead 10%
Balance aluminium.

WHAT WE CLAIM IS:—

1. A plain bearing or bearing material comprising a backing strip on which is deposited, by hot metal spraying, a bearing layer consisting of finely comminuted particles of at least two different metal constituents, one constituent comprising aluminium, while the other constituent comprises lead.

2. A plain bearing or bearing material as claimed in Claim 1, in which the layer is homogeneous.

3. A plain bearing or bearing material as claimed in Claim 1 or Claim 2, in which there is 5% by volume of the lead.

4. A plain bearing or bearing material as claimed in any of the preceding claims, including a spray-deposited intermediate bonding layer between the backing strip and the bearing layer, formed of a material different from those of the backing strip and the bearing layer.

5. A plain bearing or bearing material as claimed in Claim 4, in which the intermediate layer comprises a non-ferrous metal or alloy, for example a copper-based material, a molybdenum based material, or a nickel aluminide material.

6. A plain bearing or bearing material as claimed in any of the preceding claims, in which the backing strip is of aluminium.

7. A plain bearing or bearing material as claimed in Claims 1 to 5, in which the backing strip is of ferrous material such as steel, which is coated with a layer of nickel before the bearing layer or intermediate layer is deposited thereon.

8. A plain bearing or bearing material as claimed in any of the preceding claims, in which the aluminium represents at least 70% by weight of the bearing layer.

9. A method of forming a plain bearing or a bearing material, in which two constituent metals or alloys, respectively aluminium and lead, are sprayed in the form of hot plastic particles, simultaneously onto a backing strip.

10. A method as claimed in Claim 9, in which the metal constituents of the bearing layer are sprayed through one or more hot metal spray guns.

11. A method as claimed in Claim 10, in which the two different metal constituents are fed in the form of a single composite wire or strip to a common spray gun.

12. A method as claimed in Claim 11, in which a composite strip is fed to the spray gun in the form of a rod having a core consisting of one constituent and a sheath of the other constituent.

13. A method as claimed in Claim 10, in which the constituents are sprayed through separate spray guns.

14. A method as claimed in any of the preceding Claims 9 to 13, in which the backing strip is preheated to a temperature of at least 150°C. before the metals are sprayed thereon.

15. A method as claimed in any of the preceding Claims 9 to 14, in which an intermediate bonding layer of a material other than the sprayed metals is deposited on the backing strip before the metals are sprayed thereon.

16. A method as claimed in Claim 15, in which the intermediate layer comprises a molybdenum based material, or a nickel aluminide material, or a copper based material, which is sprayed onto the backing strip.

17. A method as claimed in any of the preceding claims 9 to 16, in which the backstrip is of ferrous material, and is coated with a layer of nickel before the bearing layer or the intermediate layer is deposited.

18. A method as claimed in any of the preceding Claims 9 to 17, in which the lead comprises 5% by volume of the bearing material.

19. A method as claimed in any of Claims 9—18, in which the constituents are sprayed from stationary nozzles onto a moving backing strip, the sprayed areas of the different jets being arranged to overlap, or substantially coincide, in the direction of movement of the backing strip.

20. A method as claimed in any of the preceding Claims 9 to 19, in which the constituents are spray deposited in the presence of a protective gas such as nitrogen which will minimise formation of oxides.

21. A method as claimed in any of the preceding claims 9 to 20, in which a high velocity gas stream is directed around the margins of at least one of the constituent spray jets, to control the shape of the spray jet into a fan extending across the backing strip transverse to the direction of relative movement.

22. A method as claimed in any of the preceding claims 9 to 21, in which one constituent is sprayed through a number of nozzles arranged as a group extending transversely across the backing strip relative to

the direction of movement, and the other constituent is sprayed through a nozzle or nozzles displaced from the first group of nozzles in the direction of relative movement.

23. A method as claimed in any of claims 9—22 in which the constituents are sprayed through nozzles which are some inches from the surface of the backing strip.

24. A method as claimed in any of the preceding claims 9 to 23, in which the lining is applied in consecutive layers and each layer of sprayed metal is between 0.004″ and 0.010″ in thickness.

25. A method as claimed in any of the preceding claims 9 to 24, in which the total thickness of the sprayed bearing layer is between 0.02″ and 0.06″.

26. A method as claimed in any of the preceding claims 9 to 25, in which the completed bearing layer of sprayed metal is compacted by rolling.

27. A method as claimed in any of the preceding claims 9 to 26, in which the proportion of aluminium in the completed layer of sprayed metals is between 70% and 98%.

28. Apparatus for depositing aluminium and lead as two different metal constituents to form a bearing layer on a backing strip, comprising means for moving the backing strip continuously past a spraying station, at least two separate hot metal spray guns at the spraying station loaded respectively with aluminium and lead, for spraying the constituents separately and arranged to direct hot metal particles onto the backing strip, the spray guns being so mounted that the sprayed areas can be arranged to overlap, or substantially coincide.

29. Apparatus as claimed in Claim 28, in which the spray guns are adjustable as to position and angular attitude.

30. Apparatus as claimed in Claim 28, or Claim 29, in which the nozzles of the spray guns are within some inches of the backing strip.

31. Apparatus as claimed in any of Claims 28 to 30, including a first group of spray nozzles arranged transversely across the strip, for spraying one constituent, and a second spray gun nozzle, for spraying the second constituent, positioned downstream of the first group.

32. A plain bearing or bearing material according to Claim 1 and substantially as described herein.

33. A method of forming a plain bearing or bearing material according to Claim 9 and substantially as described herein.

34. Apparatus for forming bearing material substantially as described with reference to the accompanying drawings.

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1083003 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

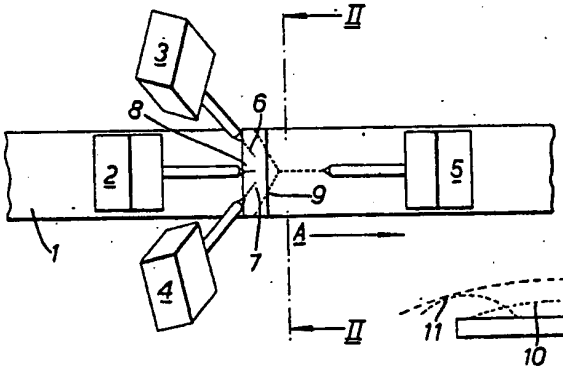

FIG. 1.

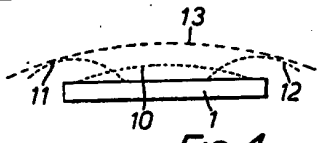

FIG. 4.

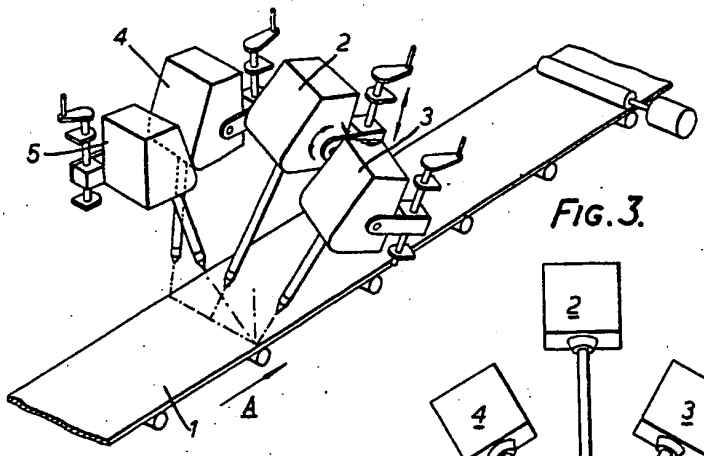

FIG. 3.

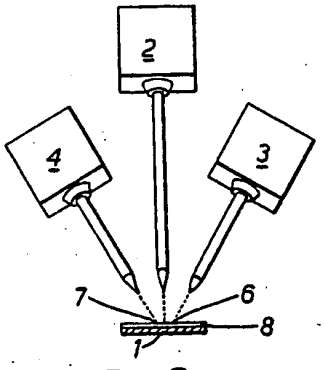

FIG. 2.